Space Weather Technical Forecast

Issued on Thursday, 14 September 2023 at 01:30 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Isolated M-flares likely (R1-R2 radio blackouts) for all days. Chance of G1/Minor storms on day 1 (14 Sep).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with mainly low-level C-class flares observed. The largest event was a C5.5 flare at 13/0810 UTC from AR3423 in the northwest. There are currently eight sunspot regions on the visible disc, including two unnumbered regions at present. AR3423 (Ekc/Beta) in the northwest remains the largest spot on the disc and provides the bulk of the flare risk, but has shown little overall change in appearance and remains largely inactive. AR3425 (Cro/Beta), also in the northwest, remains a small to moderately sized, but elongated region comprised of a large number of small spots. AR3429 (Cri/Beta-Gamma) in the eastern disc continues to display some magnetic complexity, but has only demonstrated slow growth and emergence of its numerous small intermediate spots. There has been further slow growth of AR3430 (Cro/Beta) in the southwest, with some consolidation of the penumbra surrounding the lead spot and some occasional spot proliferation in the intermediate portion of the group. The remaining regions are magnetically simple and inactive at this time. No Earth directed CMEs were observed during the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar parameters were indicative of the waning effects of a CME that arrived at Earth on 12 Sep, amidst a generally background solar wind regime. Solar winds observed at L1 by ACE/DSCOVR have varied between slightly elevated and background levels, with a peak of 463km/s at 13/0428 UTC. Density was largely at average levels, but with brief periods of above average density during the first half of the UTC day on 13 Sep (peaking 17 ppcc at 13/0710 UTC. More persistently below average levels have been observed since 13/13/1800 UTC. The Interplanetary Magnetic Field (IMF), Bt, started the period at Moderate levels (peaking 13nT at 13/0023 UTC). It has erratically reduced during the period back to predominantly Weak levels, but has recently increased back to Moderate again. The north-south component, Bz, was moderately negative (southward) to start the period. Short-lived weakly positive (northward) intervals have been observed, otherwise largely weakly negative Bz has been recorded. Phi angle has been mostly positive (away from the Sun).

Geomagnetic activity was at G1/Minor storm levels at the start of the period, with a Kp5 interval observed 13/0001-0300 UTC. Thereafter activity was at Quiet to Unsettled levels (Kp1-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has been at background. GOES16 high energy (greater than 2MeV) electron flux was at background to moderate levels. The associated 24-hour fluence was well below the Active threshold, with 1.35e6 integrated pfu observed at 14/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low with isolated M-flares likely and a slight chance of isolated X-flares.

Solar Wind / Geomagnetic Activity: Two CMEs that left the sun on 11 Sep may give glancing blows at Earth between day 1 and 3 (14-16 Sep), however, any potential effects at Earth are

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expected to be small if they do arrive.

Earth is currently in a background solar wind regime. A number of high-speed stream influences from coronal holes are expected during the period, beginning on day 1 (14 Sep) onwards with speeds increasing to Slightly Elevated or Elevated levels initially, then perhaps to Strong levels by day 3 (16 Sep). Speeds then only slowly easing on day 4 (17 Sep), but likely still at Elevated levels.

Overall, largely Quiet to Unsettled (Kp2-3) geomagnetic activity is forecast, but with a chance of Active (Kp4) intervals and slight chance of G1/Minor Storm (Kp5) intervals, most likely on day 1 (14 Sep) with a diminishing, low or very low chance on subsequent days.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at background levels, with a very slight chance of an enhancement should any larger flares occur. High energy (greater than 2 MeV) electron flux is likely to be suppressed at background to briefly Moderate levels through much of the period. Perhaps with an increase to diurnally High levels on day 4 (17 Sep). Overall, the 24 hour fluence is expected to remain below the Active threshold throughout the period.

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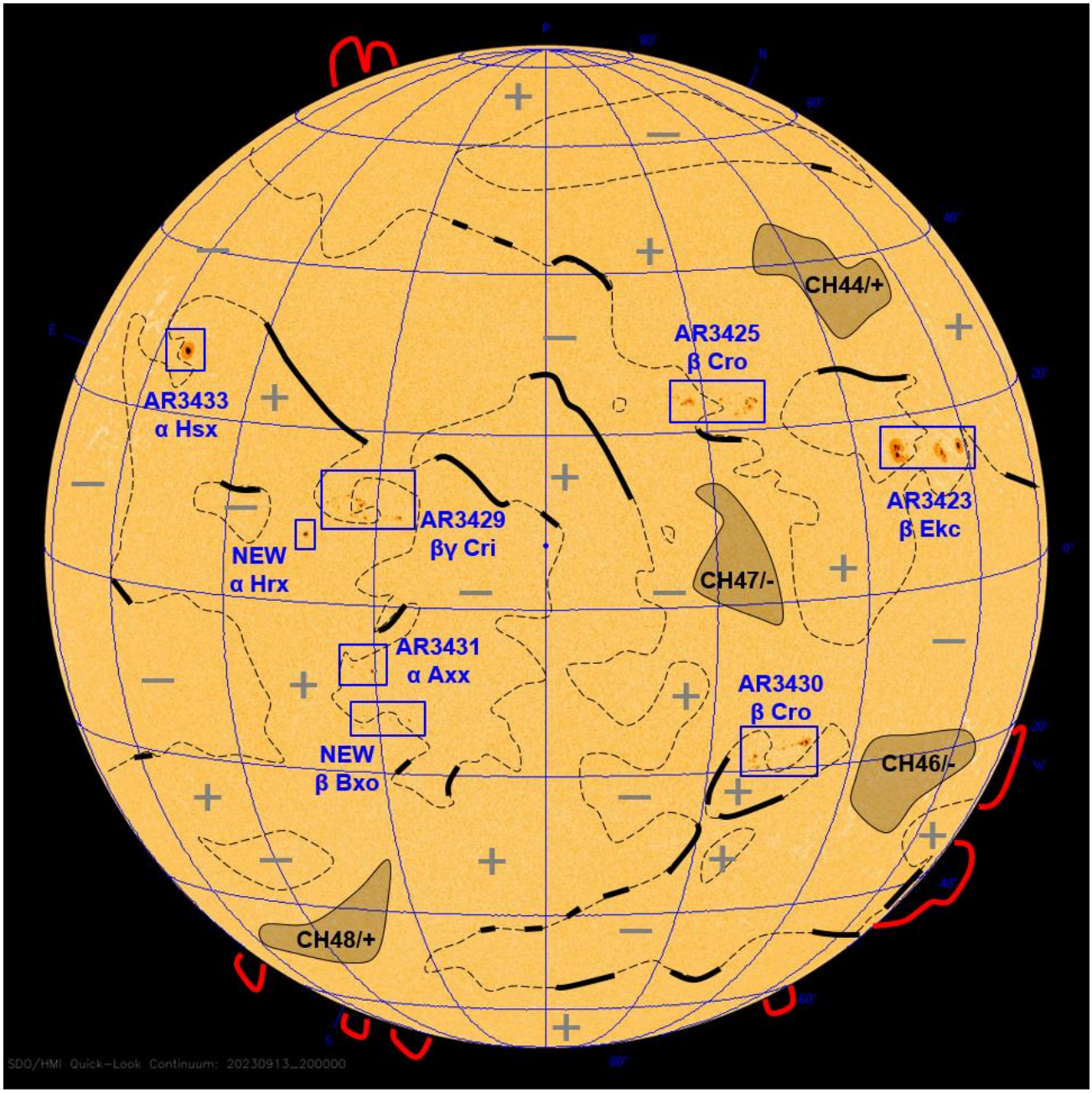
Figure 1. Solar Analysis Valid 13/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is the possibility for two glancing impacts from CMEs in the forecast. The first resulting from a M1.3 and associated filament eruption from AR3429 around 11/0130 UTC. This was a fairly large and well defined in coronagraph imagery, but originated from an area in the far northeast quadrant. There is a slight chance of a glancing impact from this either late day 1 (14 Sep) or early day 2 (15 Sep). A second CME resulted from a filament eruption in the south-centre disc around 11/1400 UTC. This gave a CME which appeared slow, largely southward directed and relatively faint in imagery. Analysis has shown that this may give Earth a weak glancing blow possibly later on day 2 (15 Sep) or early day 3 (16 Sep). Overall, little effect on Geomagnetic activity is expected from either of these CMEs if they arrive at Earth.

Recent CME influence from 12 Sep appears to have waned with an ambient solar wind regime expected, at least in the short term. Coronal hole fast wind enhancements are expected into the forecast period however, firstly most likely from CH44/+ in the northwest disk, though ENLIL model output continues to signal CH46/- in the southwest as the dominant feature. The onset of the influence from either or both these features is expected on day 1 (14 Sep) with an increase in winds to Slightly Elevated to Elevated levels (450-550km/s) likely. From day 2 (15 Sep) a connection to equatorial CH47/-, in the western hemisphere is likely. This features was perhaps the source of some Strong solar winds (around 600km/s) on the last solar rotation, with a chance that winds may reach these levels by day 3 (16 Sep) before slowly easing on day 4 (17 Sep), though probably still at Elevated levels. Geomagnetic activity with this high-speed stream on the last rotation was muted (peaking at Kp3 - Unsettled), despite the Strong solar speeds observed. Negative polarity coronal holes are generally less geo-effective at this time of year, so similar Geomagnetic activity is probable again with this enhancement.

The above creates a somewhat complex and lower than average confidence forecast, with a variety of potential coronal hole and minor CME interactions. There is little assistance at present from ENLIL modelling. Overall, largely Quiet to Unsettled (Kp2-3) geomagnetic activity is forecast, but with a chance of Active (Kp4) intervals and slight chance of G1/Minor Storm (Kp5) intervals, most likely on day 1 (14 Sep) with a diminishing, low or very low chance on subsequent days.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	10	10	5
Strong	G3	No	3	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Met Office Space Weather Technical Forecast

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0357	Partial	M1.3 flare and filament eruption	AR3429	626 km/s	14/1800 +/- 9 hours	Limited shock expected. Low confidence arrival
12/0209	Partial	Filament eruption	SE	450 km/s	15/1800 +/- 9 hours	Limited shock expected. Low confidence arrival

Radio Blackouts - X-Ray Flares:

Generally Low activity is expected to continue with isolated M-flares likely and a slight chance of isolated X-flares.

There are currently eight active regions visible on the disc. AR3423 in the northwest remains the largest group and provides the bulk of the flare risk, but has shown little overall change in appearance and remains largely inactive. AR3425, also in the northwest has decreased in size with penumbra surrounding the lead and trailer spots becoming less well defined and only a small intermediate spot remaining. AR3429 in the eastern disc continues to display some minor growth within its intermediate spots and increase in areal extent. It maintains a Beta-Gamma Mount Wilson magnetic configuration indicating some complexity that could result in significant flares. There has been further slow growth of AR3430 in the southwest, with some consolidation of the penumbra surrounding the lead spot and some spot proliferation in the group. The remaining regions are magnetically simple and inactive at this time.

AR3423 is expected to rotate off the visible disc on day 3 (16 Sep), however, far-side sounding data suggests that a new region will rotate onto the visible disc in the southern hemisphere on day 1 (14 Sep). Then a large region is expected to rotate over the eastern horizon on day 3 (16 Sep) into day 4 (17 Sep). This is expected to be the returning Ex-AR3413 and was responsible for numerous M-flares when last on the visible disc. A number of large, far-sided CMEs can likely be attributed to the region in the past several days, suggesting it is still active and at least currently, poses a risk for significant flares. In light of this, conservatively, the current flare risk is maintained throughout the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels. There remains a very slight chance of flux levels rising in response to any significant flaring, particularly as AR3423 and AR3425 continue to move across the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux observed by GOES-16 is expected to remain generally at background to Moderate levels through much of the period, with geomagnetic activity at above background levels due to coronal hole high-speed stream and possible CME influences. By day 4 (17 Sep) electron flux may rise to High levels at diurnal peak as geomagnetic activity likely subsides.

The associated 24-hour fluence will most likely remain below the Active (1e8 integrated pfu) threshold throughout the period. MOSWOC REFM is considered to be giving good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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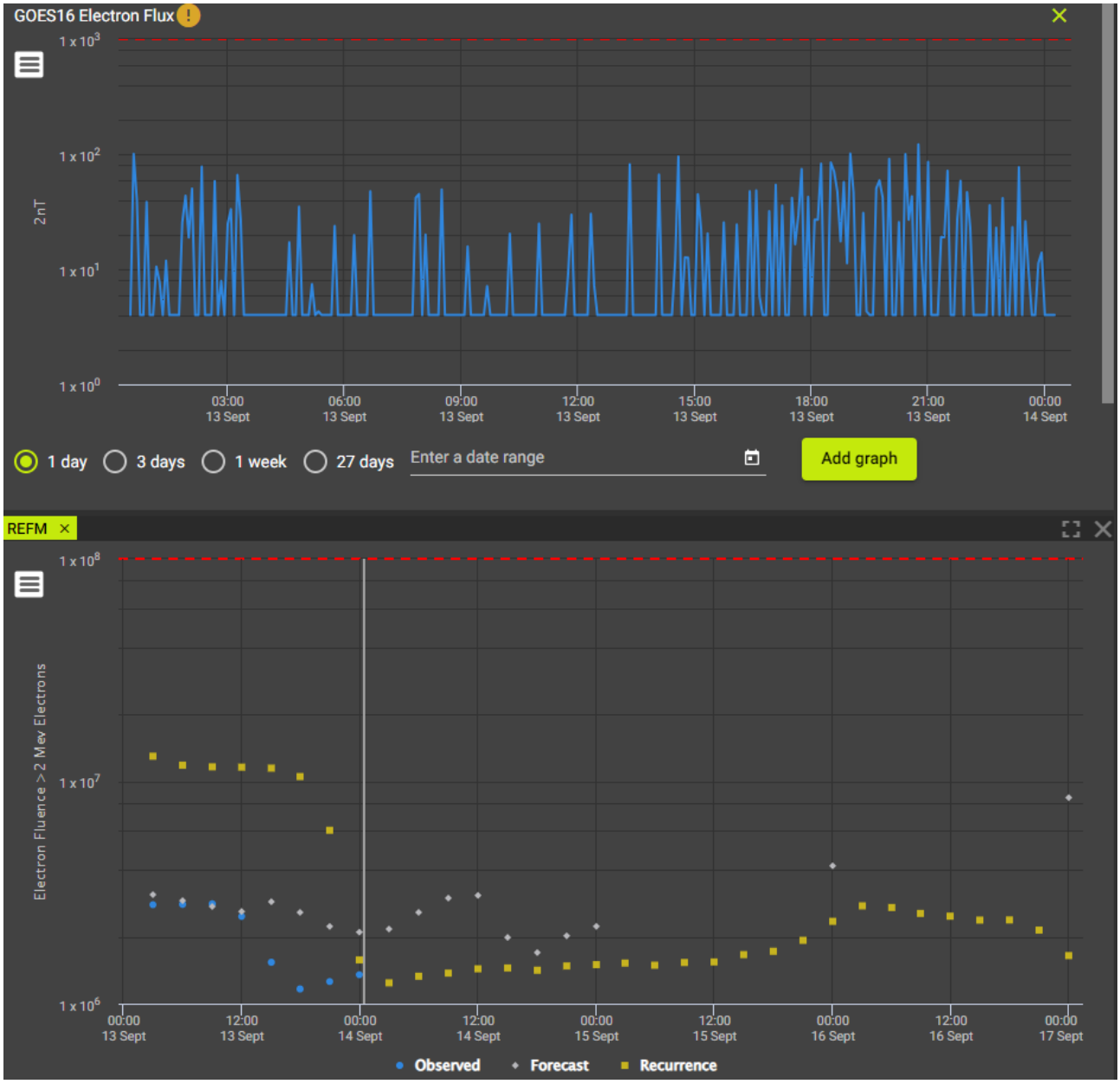
Figure 2: GOES-16 >2MeV Electron Flux (above) and MOSWOC Fluence forecast and recurrence (below)



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